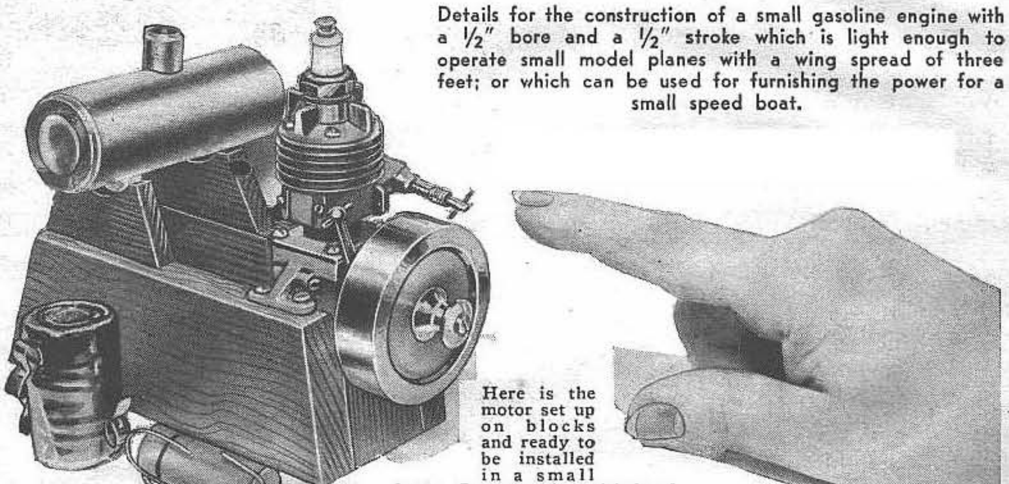
Making a Model Gasoline Engine

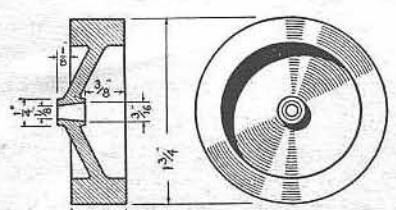
Details for the construction of a small gasoline engine with a 1/2" bore and a 1/2" stroke which is light enough to operate small model planes with a wing spread of three feet; or which can be used for furnishing the power for a small speed boat.



Here is the motor set up on blocks and ready to be installed in a small boat. Compare size with hand. The finger is pointing to the carbureter adjustment. In the foreground is ignition coil and condenser.

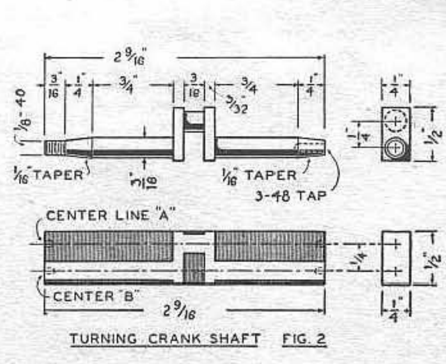
THIS small ½" bore and stroke gasoline engine may be made on any small lathe that has a swing of 3" or more. The main purpose of presenting this engine is to enable the average man to own a small gas-powered plane or boat without the expense that is attached to building a six- or seven-foot wing spread plane or a one-meter boat. The proper size plane for an engine of this size would have a wing spread of only three feet or so. This engine is a Parohl design with modifications enabling you to use either a one- or two-bearing crankcase. For the average modelmaker a one-bearing crankcase probably is best, since it requires less machine work. Of course, the one-bearing engine will have to have its bearing replaced more often than the two-bearing job. Both methods of construction are given here.

With the exception of the crankcase,



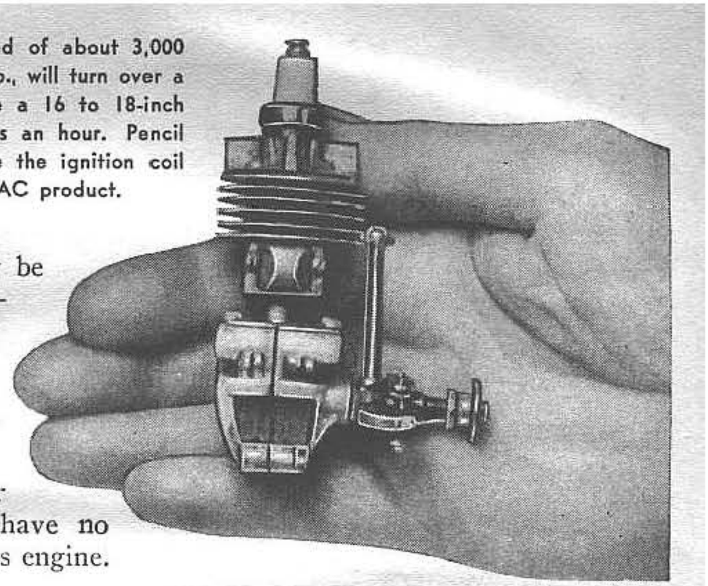
FLY WHEEL FIG. 1

Note tapered hole at center of fly-wheel. The shaded portion indicates the parts that are to be cut away in turning the crank-shaft. Turning is first done using center line A.



TURNING CRANK SHAFT FIG. 2

This small engine turns over at a speed of about 3,000 r.p.m. under no load. It develops 1/8 h.p., will turn over a seven-inch airplane propeller and drive a 16 to 18-inch hydroplane hull at a speed of 18 miles an hour. Pencil flashlight batteries are used to operate the ignition coil and the spark plug is a standard AC product.



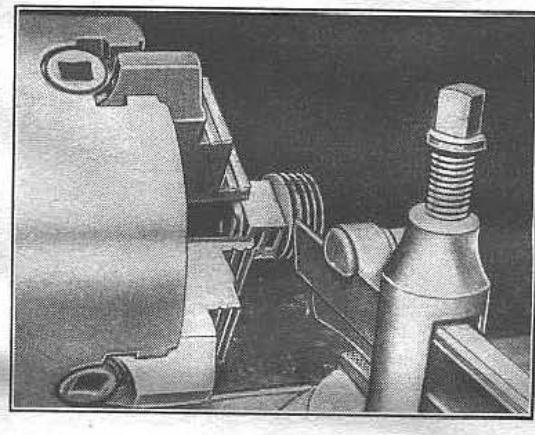
If the engine is to be used in a model airplane, no fly-wheel is needed.

The finished construction then takes on this appearance.

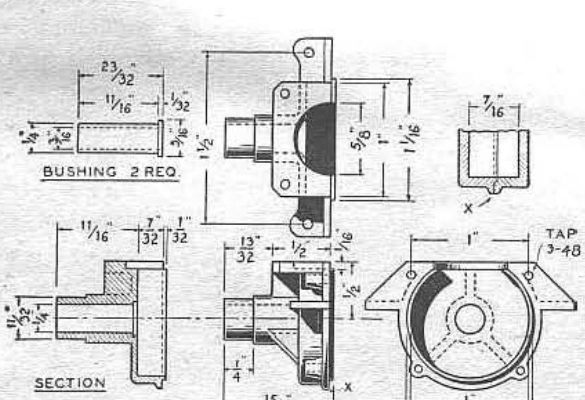
head and timer, all parts may be cut from solid stock, if so desired. We shall construct the engine on the theory that you are using castings, since the work involved in cutting the parts from solid is increased many fold. The man familiar with making patterns should have no difficulty in making a set for this engine.

The hub on the front of the fly-wheel casting should be gripped in a four-jaw chuck, then the rear and face of the fly-wheel should be turned to finish size. When taking the first cut on any iron casting, always make sure your tool goes under the hard skin of the casting. Failure to do so results in a dull or broken tool, since the skin of a casting contains hard spots and sand. Now drill an 1/8" hole in the fly-wheel for the crankshaft. After this hole is drilled, bore it on a taper so that the rear of the hole is 3/16" in diameter and the front is 1/8" in diameter. If you have no small boring tool on hand you may make one from a ten cent rat-tail file. Take light cuts because small boring tools chatter very easily and may mar the finish of the work. The next step is to remove the fly-wheel from the chuck and, turning it around, cut off the nib and finish the front in the same manner as you machined the rear. For the one-bearing engine a small flat must be filed on the rear hub of the fly-wheel. This forms the cam for the timer.

The crankshaft is the only job in

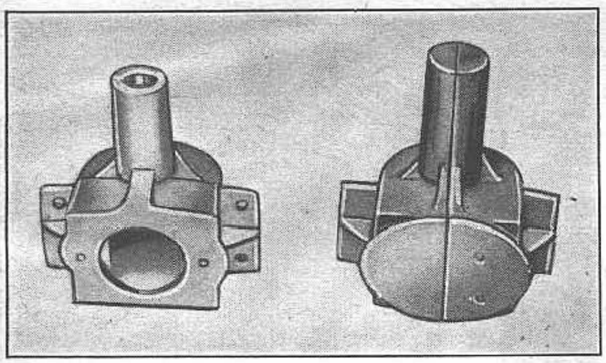


Turning the cooling fins on the cylinder of the engine. For this job a parting tool is used.



CRANK CASE 2 REQUIRED FIG. 3

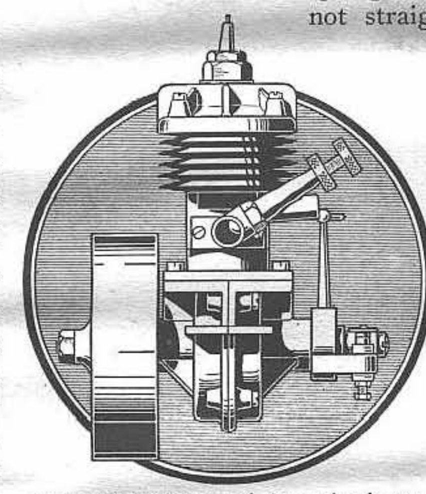
The male and female portions of the crank-case are illustrated in this diagram. Dimensions of the parts when turned to finish are given here. If the builder wants to make up his own castings he will have to make the pattern large enough to allow for shrinkage.



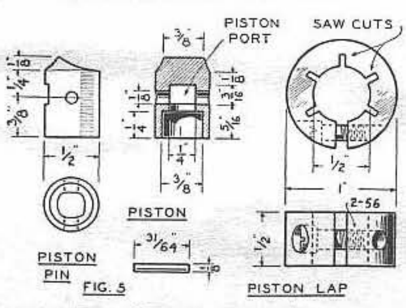
This is the way wooden patterns are made for the engine. Plastic wood will be found handy for fillers.

the entire engine that requires more than average care in machining. Directions will be given for machining a two-bearing crankshaft first. The shaft is cut from a solid piece of cold-rolled steel $\frac{1}{4}''$ thick, $\frac{1}{2}''$ wide and $2\frac{9}{16}''$ long. Extreme care must be used in laying out the lathe centers as shown in the drawing. When ready to use a center drill, choose the smallest one you have in your tool box —then buy one that is even smaller. After the centers are drilled and the piece is ready to insert in the lathe use centers A and, taking very *light* cuts, machine away the portions which are shaded in the drawing. After you have machined the crank, shift the lathe centers to center holes B, and machine the shafts, finishing according to the dimensions given in the drawings. When machining the shafts make sure your centers are not too tight, for, if you spring the crankshaft, you can not straighten it and you will have to start all over again. A small block, placed between the webs of the shaft, will help keep it straight.

The crankshaft for the single-bearing engine is the ace of simplicity. A piece of $\frac{3}{16}''$ diameter drill rod furnishes the shaft. Machine it to the dimensions shown. Chuck a short piece of $\frac{3}{4}''$ diameter cold-rolled steel and drill a 13/64″ hole in its center for a $\frac{1}{4}$-20 tap. Drill and tap the hole for the crank pin as shown. Now face off the front of the steel and, with your parting tool cut off a

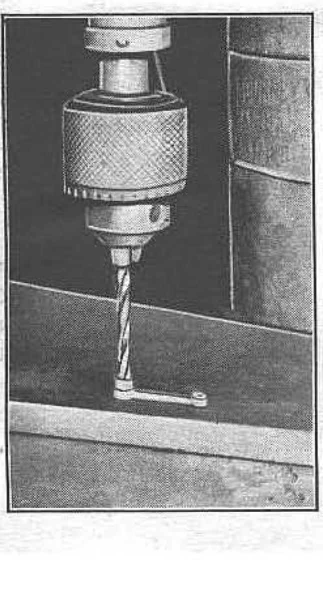


As assembly diagram of the engine is presented here. The wiring diagram is not included, as this is standard.

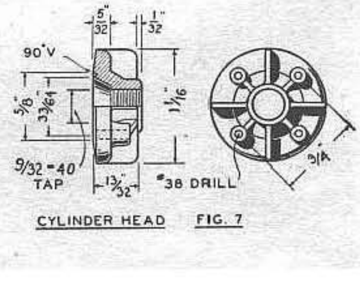


The above diagram shows the construction of the piston and piston lap for this engine. Make sure that the top of the piston is shaped correctly with relation to the piston pin.

Cylinder head dimensions are given at the right. If the construction is cut out of a solid block, a small hand grinder can be used to cut away surplus metal.



Left—Drilling the crank-shaft.



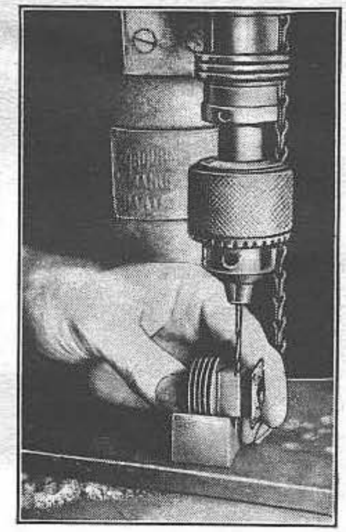
CYLINDER HEAD FIG. 7

washer which is exactly 3/32" thick. Machine the crank pin to the dimensions given, using a piece of $\frac{3}{16}$" diameter drill rod. When tapping a short section of rod, such as the threaded portion of the crank pin, always leave the rod a little longer than needed and after threading it machine to the finished length. This prevents spoiling the end due to the die slipping when starting the thread.

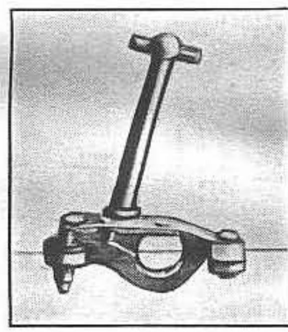
The crankcase for the two-bearing engine is to be machined next. Grip one of the crankcase castings by the long nub projecting from it and face off the end. Now bore out the center to the depth and width shown in the drawing. Counter - bore or recess for a depth of 1/32" and $\frac{1}{16}$" larger in diameter. This casting now becomes the female casting of the crankcase and will be referred to as such in the future. Using a new ¼" drill, drill a hole through the crankcase nub. This hole is for the bearing. Counterbore this ¼" hole for a depth of $\frac{1}{32}$" and $\frac{5}{16}$" in diameter.

The same method is followed in machining the second half of the crankcase, except that instead of recessing the face of this casting, a lip is left projecting, so that the rim will fit into the female casting, thus producing a mechanical seal. Fit the two halves together and drill and tap for the holding screws. Now, gripping the crankcase by the male end, turn the outside of the bearing support to the dimensions given. The timer fits on this end. For the one-bearing motor, the halves of the crankcase are machined the same way, with the exception that the ¼" diameter hole is not drilled through the male half, and the bearing projection is cut off as close to the case proper as you can saw.

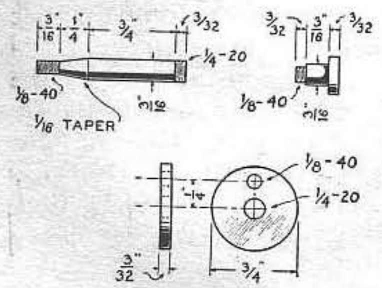
After the crankcase halves are fitted together, slip a ¼"



With the cylinder held on a V block, located on the bed of a drill press, the holes are drilled through the sides for the port, as shown in the photograph at the right.

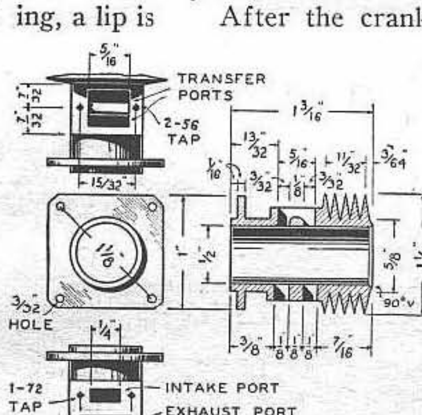


The photo below shows the finished timer. This is operated by a cam on the crank-shaft.

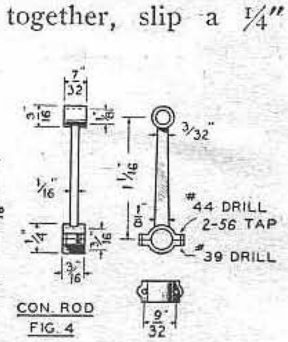


SINGLE BEARING CRANK SHAFT
FIG. 2A

The builder will find that a single bearing job is much easier to construct. The details of the single bearing are given above. Only one hole is bored through the crankcase and only one bushing is required there if the single bearing engine is to be made.

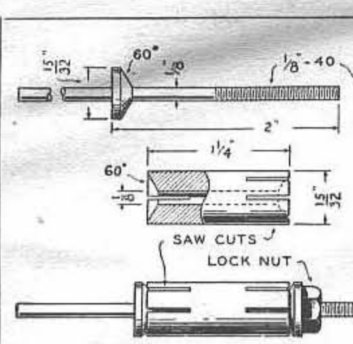


CYLINDER FIG. 6



CON. ROD
FIG. 4

Connecting rod dimensions and details for construction of the cylinder are given in the diagrams above and at the left.

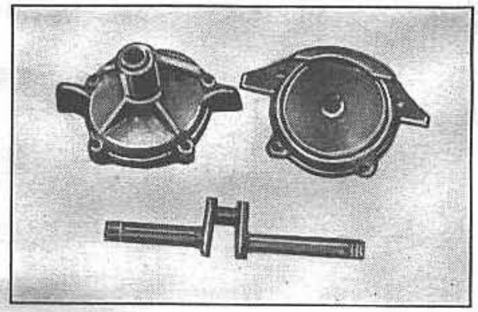


LAP FOR CYLINDER FIG. 8

The lap for the cylinder is easy to make as the illustration at the left shows. Do not use carborundum when lapping the cylinder, but use pumice stone and water instead.

diameter bar through the bearing holes. You are now ready to machine the top of the crankcase where the cylinder is fitted. Find the center of this top face by moving the crankcase around in the chuck jaws; lock the jaws and proceed to face off this top. Bore out the center to a width of 5/8" in diameter. One more step and the crankcase is finished. Take the case apart and machine two bearings from phosphor bronze, following the drawings. Make these bearings about two thousands oversize on the 1/4" diameter dimension; force them into the crankcase bearing holes. If they go in too stiffly, remove and machine smaller. They should present a tight fit. Aftey they are in place, run a reamer through to remove any burrs that have been made during the fitting.

With a file clean up the connecting rod casting. Drill and tap the holes on the bottom bearing. Using a fine-bladed saw, cut the bottom bearing in half and then bolt the halves back together. Mark off and center-punch the centers for the bearings. Drill the holes to the dimensions given and run a reamer through them. The lap for the piston is made from a short section of brass bar. Bore the 1/2" diameter hole to the exact size indicated on the drawing and then cut the saw slots. The use of this lap will be explained later.



Finished crank-case and two-bearing crank-shaft. Great care must be exercised in making the crank-shaft, for reasons outlined in the text.

Chuck a piece of round cast-iron bar and turn it down to five-thousandths over 1/2" making a bright clean finish for a distance of 1 1/2". Face off the end and bore a 1/4" hole for a distance of 1/2". Counterbore this hole for a depth of 1/4" making it 3/8" in diameter. Exactly 3/8" up from this end drill a 1/8" diameter hole through the side of this bar. Now lap this bar down to exactly 1/2" in diameter, using pumice stone and water. Use plenty of both and run the lathe at a slow speed. If the lap heats up so that it feels uncomfortable in your hand then stop and wait for it to cool before proceeding. Emery paste may be

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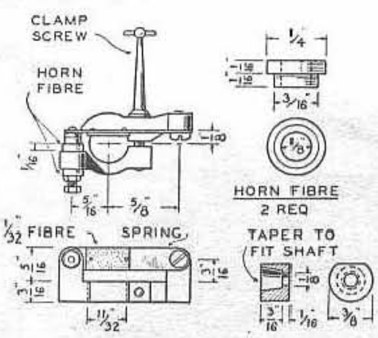
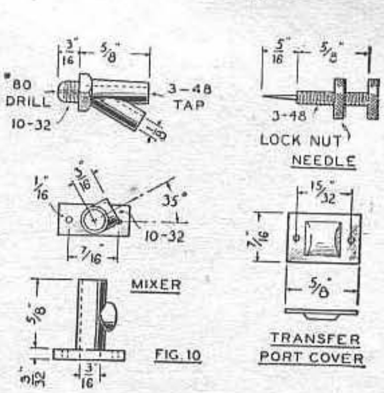


The timer details are given in the above diagram. The contacts should be of silver or tungsten.

The carbureter construction details are given at the right.



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(*Continued from page* 60)

substituted for the pumice stone and water, but, inasmuch as cast iron is porous, the grains of emery are never completely removed from the piston and will damage the cylinder walls. About two hours are required to lap the piston to finished size and you cannot rush this job. When the piston is lapped to finished size, cut it off and file the top to the shape shown in the drawing. Make sure of the wrist-pin location in relation to the top outline.

The cylinder may be made from either a casting or from a solid chunk of cast iron. In either case be sure you have fine grey iron of the highest quality. Grip a 1¼" square bar in the chuck and cut the bar down to a diameter of 1$\frac{1}{16}$" for a distance of ½". Face off the end of the bar and bore a hole eight-thousandths less than ½" in diameter for a distance of 1⅜". Machine the end to the size and shape given in the drawing for the top of the cylinder. Use a parting tool to machine the cooling fins. If you haven't a thin one available make one from a flat file following the shape of the commercial tool. You can not force a home-made parting tool, therefore take light cuts, being careful not to push the tool when it reaches the bottom of the fins. You can take off a fin more easily than you can replace it.

With a parting tool cut off the cylinder from the bar and place it on a mandrel; face off the end which is inserted into the crankcase and cut the cylinder down to the finished length of 1$\frac{3}{16}$". Lay out the port-holes and center-punch for drilling. As fast as you finish one hole plug it up with a round bar and proceed to drill the next hole in line by drilling half in the cast iron and half in the plug. In this way you will not be required to break any walls between the holes. After you have drilled them, file the ports square with a jeweler's file. Finish filing the cylinder to the shape shown in the drawing and photographs, tap the holes for the screws used in attaching the transfer port, mixer and crankcase. Last, but not least, lap the cylinder until the piston is an easy push fit. In making the lap for the cylinder, use a piece of ¼" diameter steel for the cones, cutting one cone integrally with the shaft. Tap the end with any convenient tap you have in the shop. The balance of the lap may be made easily from the sketches, Fig. 8.

Follow the drawing when machining the cylinder head. Cut a recessed 90 degree V in the cylinder head, using a thread-cutting tool. This inverted 90 degree V must fit on to the protruding 90 degree V of the cylinder. After it has been machined, place it on the cylinder and drill the holes for the screws which run through the cylinder head and into the fins of the cylinder. Follow through the cylinder

head with a clearing drill, then tap the cylinder fins. Tap the spark plug hole according to the size spark plug you are desirous of using.

The timer cam, for the two-bearing engine, is made from a piece of cold-rolled steel. The transfer port is a casting. File the face dead flat with a fine-toothed file and drill for the attaching screws. The mixture valve and carburetor, which are rolled into one, is composed of two castings that may be easily machined to the dimensions given. The needle for the needle valve is made from a darning needle soldered into the end of the screw.

Follow the timer rawings and photographs for the machining and assembly details. It is best to buy the spring complete and not to try to make one. However, if you want to make one, use a piece of main spring taken from a watch (alarm clock springs are too stiff). Punch the holes for attaching the fiber pieces to the spring by placing the spring on a lead block and striking sharply with a flat-bottom punch, do not use a center-punch. The wrist-pin is easily made with a piece of 1/8" diameter drill rod.

When you have assembled your engine, squirt heavy machine oil in the cylinder and crankcase. Turn the engine over a hundred times or so by hand, to break in the parts. Then take the engine apart and wash all parts thoroughly in gasoline. Gaskets must be used in the assembly. Make them of a good quality bond paper. Use one for the crankcase, one where the cylnider fits into the crankcase and one each where the transfer part and mixture valve attaches to the cylinder.

Now assemble, using shellac at the joints. Rig up the ignition, test the spark, open the needle valve one turn and blow through the gas tank until you see some gas dripping from the mixture tube. Place your hand over the mixture tube opening and give the fly-wheel about three turns with the ignition *off*. Close the needle valve to three-quarters of a turn, snap on the ignition key, turn the fly-wheel with a quick snap, step back and—maybe it will start. For the first three hours of running, use a gas mixture of two parts light motor oil to sixteen parts gas. When the engine is broken in you may use one part of medium motor oil to sixteen parts of gasoline.

This motor will develop a surprising amount of power and will be found suitable for operating light airplanes or power boats.